

An Environmental Intervention to Promote Lower-Fat Food Choices in Secondary Schools: Outcomes of the TACOS Study

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Trends in adolescent eating patterns have become a focus of concern in light of secular increases in the prevalence of adolescent obesity^{1,2} and increasing recognition of the contribution of diet to long-term health.^{3,4} The prevalence of overweight has increased dramatically during recent years and currently affects 24% of US children and adolescents.^{1,2} Two-thirds of US youths exceed dietary fat recommendations,⁵ and only 20% meet guidelines for vegetable intake and 14% for fruit intake.⁶ High-fat diets contribute to the development of obesity, diabetes, cardiovascular disease, and some cancers.^{3,7,8} Interventions targeting youth are important because of the potential for establishing healthful dietary patterns that may persist into adulthood and reduce chronic disease risk.^{9,10}

The school food environment can have a significant effect on adolescents' food choices because a large proportion of their total daily energy is consumed at school.^{11–13} Foods sold outside the National School Lunch Program (e.g., “competitive foods,” “à la carte” foods) make up an increasing share of students' food purchases at school, especially at the secondary level.^{11–13} Available data indicate that these foods are higher in fat compared with foods sold as part of the federally reimbursable school lunch program.^{14–17} However, competitive foods have not been the focus of school-based nutrition intervention research to date.

Adolescence is a time when youths attempt to establish independence from adult authority and when peer influence becomes more prominent.¹⁸ Peers represent an important environmental influence on secondary school students' food choices.¹⁸ Interventions with adolescent populations can make use of peers as a normative influence to promote healthful eating behaviors at school.¹⁸ Peer influence has been used in prevention interventions targeting

youth tobacco and alcohol use,^{19–21} but little work has been done in the area of peer-based nutrition interventions among adolescents.

Our study was a randomized trial that evaluated the ability of an environmental intervention to increase the sales of lower-fat foods in secondary school cafeteria à la carte areas. It was hypothesized that an increase in the availability and promotion of lower-fat à la carte foods would result in increased sales of these foods in intervention schools relative to sales of these foods in control schools.

METHODS

Trying Alternative Cafeteria Options in Schools

TACOS (Trying Alternative Cafeteria Options in Schools) was a 2-year, group-randomized, school-based nutrition intervention trial.²² Twenty secondary schools were randomly assigned to either a no-intervention control group or a multicomponent environmental intervention. The environmental intervention consisted of increasing the availability of lower-fat foods in cafeteria à la carte areas and implementing schoolwide, student-based promotions of these lower-fat foods. Primary outcomes measured were sales of lower-fat à la carte foods and student self-reported food choices.

Objectives. We evaluated an environmental intervention intended to increase sales of lower-fat foods in secondary school cafeterias.

Methods. Twenty secondary schools were randomly assigned to either an environmental intervention or a control group for a 2-year period. The intervention increased the availability of lower-fat foods and implemented student-based promotions.

Results. A steeper rate of increase in sales of lower-fat foods in year 1 (10% intervention vs –2.8% control, $P=.002$) and a higher percentage of sales of lower-fat foods in year 2 (33.6% intervention vs 22.1% control, $P=.04$) were observed. There were no significant changes in student self-reported food choices.

Conclusions. School-based environmental interventions to increase availability and promotion of lower-fat foods can increase purchase of these foods among adolescents. (*Am J Public Health.* 2004;94:1507–1512)

Twenty secondary schools in the Minneapolis–St Paul metropolitan area were recruited to take part in TACOS. Inclusion criteria were the presence of an à la carte area in the school cafeteria operated by the school food service; a food service director and principal willing to take part in the study for 2 school years; a willingness to be randomly assigned to intervention or control group; computerized à la carte sales data; and a willingness to share these data with researchers, allow a mail-based administration of student evaluation surveys, and allow student groups to collaborate with research staff on the development and implementation of schoolwide promotional activities involving foods offered in the à la carte area. Of the 25 eligible secondary schools invited to participate, 5 declined, primarily because of the respective food service directors' concern about the additional food service staff burden related to compliance with research protocols. To avoid contamination caused by schools sharing the same food service director, only 1 school per district was included in the study.

Schools were predominantly suburban and enrollment ranged from 812 to 3157 students (median: 1731 students). On average, 14% of students were non-White (range: 3%–77%), and 9% were eligible for free

lunch (range: 1%–57%). Two schools' food services were run by food service management companies, 18 schools' services were run by the school district food services, 19 schools prepared meals on-site, and 20 schools participated in the National School Lunch Program.^{11–13}

Intervention Components

The TACOS intervention consisted of 2 main components that addressed the school food environment: food availability in cafeteria à la carte areas^{11–15} and peer influence via peer promotions for lower-fat foods.

Food availability in à la carte areas. The goal for the à la carte food availability intervention component consisted of increasing the availability of lower-fat foods offered à la carte.^{11–15} "Lower fat" was defined as 5 g or less fat per serving, and "à la carte" was defined as foods sold separately from the federally reimbursable school lunch program and offered at least 3 days per week.

Before the first intervention school year, TACOS staff conducted a baseline inventory of all à la carte foods and calculated the percentage of lower-fat foods in the product mix.²² Initial goals were to increase lower-fat à la carte food availability by 30% relative to baseline. The ultimate goal was to have 50% of products be lower fat. TACOS staff and school food service staff worked collaboratively throughout the 2-year intervention to increase the proportion of lower-fat foods available in à la carte areas with school-specific, tailored lists of higher- and lower-fat foods. Quarterly meetings between research and food service staff were held to review progress toward goals.

Peer promotions. TACOS addressed peer influence on adolescent food choices through a peer promotions intervention component of the study. Student groups implemented schoolwide promotional activities that highlighted 1 or more of the lower-fat foods available in the à la carte areas. TACOS staff worked with the student groups and their faculty advisors to train the students for specific promotional activities and to act as liaisons between students and the food service staff. Each promotion required approximately 2 to 3 weeks to prepare and lasted 1 to 5 days. Promotions included taste tests, student

food choice self-assessments, and media campaigns (posters, newspaper articles, and videos). Student groups were offered financial incentives for completing each promotion (from \$100 to \$300, depending on the complexity of the promotion).

Outcome Evaluation

TACOS evaluated the intervention in 2 ways: the percentage of lower-fat à la carte foods sold and students' self-reported food choices.

À la carte sales. Sales data were collected on a weekly basis in electronic format from school food service staff in each of the 20 schools. To separately track higher- and lower-fat food sales, cash register keypad overlays were modified before the beginning of the school year to ensure that higher- and lower-fat food items were keyed on separate keys. Food service staff at both intervention and control schools received training at the beginning of each school year to ensure that they understood how to correctly key the higher-fat and lower-fat à la carte foods. Accurate keying of à la carte foods by food service staff was ensured with regular in-person observation visits by TACOS staff every 3 weeks. Food service staff received small financial incentives if keying accuracy was 90% or higher. Keying accuracy averaged 97% during year 1 and 98% during year 2 and was similar in intervention and control schools.

School food service revenues. Data on school food service revenues were collected at the end of each school semester. These data were generated from the same point-of-sales software program used to track school cafeteria food sales. Variables examined included revenues from student reimbursable lunches, student à la carte foods, total à la carte foods, and total school food service revenues.

Student survey data. Student food choices were measured via a mailed survey to a random sample of 75 students per school, according to the Dillman method,²³ during the fall of 2000, the spring of 2001, and the spring of 2002. Surveys comprised 48 questions related to students' food choices, attitudes and perceived norms regarding lower- and higher-fat foods, perceptions of the

school food environment, use of the school cafeteria and vending machines, and demographic variables. Mean response rates for the 3 surveys were 75%, 75%, and 77%, respectively, and did not differ significantly between intervention and control schools.

Lower-fat food choices. Students reported whether they had eaten, the day before, any of the foods listed on a food frequency checklist of 28 groups of foods. The food frequency checklist was based on a food checklist instrument used in previous school-based nutrition intervention trials.²⁴ Additional foods targeted by the intervention were added to the checklist (e.g., low-fat cookies, baked chips). Response options were yes or no. Portion size was not measured.

Lower-fat food choices were calculated as the ratio of lower-fat foods to higher-fat foods reported from the checklist (LF/HF ratio). The total number of lower-fat food choices on the checklist was 6; the total number of high-fat foods was 22. The correlation of the LF/HF ratio and a single 24-hour recall measure of percentage fat energy was $r = -.33$ ($P < .0001$) among a sample of 186 secondary school students.

Added fats score. An added fats score was created by summing responses to 5 questions about fats added to foods eaten on the day before the questions were answered. The correlation between the added fats score and a single 24-hour recall measure of percentage fat energy was $r = .26$ ($P < .0003$) among a sample of 186 secondary school students.

Fruit and vegetable score. A fruit and vegetable score was created by summing responses to 6 questions about usual intake of fruits and vegetables during the past year.²⁵ The correlation between the fruit and vegetable score and a single 24-hour recall measure of percentage fat energy was $r = -.23$ ($P < .002$) among a sample of 186 secondary school students.

Perceived environment and behavioral intentions. Twenty-one questions rate on a Likert scale, measured students' perceived environment and intentions regarding food choices (Table 1). Three additional questions measured students' perceptions of the number of low-fat foods available in the lunch main line, à la carte areas, and snack vending machines.

TABLE 1—Student-Reported Food Choices, Perceived Environment, and Behavioral Intentions, by Intervention Group

	Intervention Schools (n = 10)			Control Schools (n = 10)			P ^a
	Baseline	Spring Year 1	Spring Year 2	Baseline	Spring Year 1	Spring Year 2	
Food choices, % yes							
Low-fat/high-fat ratio ^b	0.29	0.28	0.28	0.23	0.26	0.24	.62
Added fats score	2.5	2.6	2.4	2.6	2.7	2.5	.97
Fruit and vegetable score	2.7	2.9	2.9	2.8	3.1	3.1	.95
Perceived environment, % yes ^c							
School cafeteria offers enough low-fat foods	2.5	2.7	2.9	2.5	2.5	2.4	.001
It is easy to tell which foods are low-fat/high-fat in the school cafeteria	2.9	3.0	3.2	2.9	2.9	2.9	.03
It is easy to buy low-fat foods in the school cafeteria	3.1	3.3	3.4	2.9	2.9	2.9	.05
It would be hard for me to buy a low-fat food instead of a high-fat food at school	3.2	3.2	3.3	2.9	3.0	3.0	.83
My friends usually eat high-fat foods at school	2.4	2.4	2.5	2.4	2.4	2.3	.23
My friends usually buy low-fat foods from the school cafeteria	2.4	2.5	2.6	2.4	2.4	2.3	.01
Adults at school encourage me to buy low-fat food	2.3	2.5	2.7	2.2	2.2	2.2	.007
Adults at home encourage me to eat low-fat foods	3.2	3.3	3.3	3.2	3.3	3.3	.98
We usually have low-fat foods in my home	3.4	3.4	3.5	3.4	3.4	3.5	.67
Behavioral intentions, % yes ^c							
I plan to buy fewer high-fat foods for lunch during the next week	3.0	3.0	3.1	2.9	3.1	3.0	.36
I plan to buy a low-fat food next time I buy food in the school cafeteria	2.8	2.9	3.0	2.8	2.9	2.9	.31

^aP value for time × condition interaction. Means adjusted for grade, gender, and race/ethnicity.

^bNumber of low-fat foods checked (0–6) divided by number of high-fat foods checked (0–22).

^c1 = disagree; 5 = agree.

Process Measures

Percentage low-fat à la carte product mix. To monitor the extent to which intervention schools implemented their lower-fat à la carte food availability goals, trained research staff visited each intervention school every 3 weeks to record all foods offered at lunchtime in the à la carte areas. In addition, complete à la carte inventories in intervention and control schools were conducted by trained research staff at baseline and after the second intervention year.

Promotions implementation. TACOS staff completed a promotions process evaluation data form for every promotional activity conducted. Date, source (i.e., the group that implemented the promotion: TACOS staff, student groups, or combination), type of promotion, number of students trained, promotion duration, and amount of financial incentive earned were recorded.

Student exposure. Student exposure to the TACOS intervention activities was assessed with a series of 4 questions on the mailed student survey (Table 2).

Statistical Analysis

The primary outcome variable was percentage of lower-fat à la carte food sales calculated from the weekly à la carte sales data. It was hypothesized that the percentage of lower-fat sales would be higher and would increase more rapidly in the intervention schools relative to the control schools. Graphs of data by school showed that the first 3 weeks and last 3

TABLE 2—Student Awareness of TACOS Study

	Intervention Schools (n = 10)			Control Schools (n = 10)			P ^a
	Baseline	Spring Year 1	Spring Year 2	Baseline	Spring Year 1	Spring Year 2	
Student awareness, % yes							
Seen any posters in school about cafeteria food choices?	49	69	85	40	39	35	.0001
Heard any messages over public address system, in school newspaper, or on school television about cafeteria food choices?	53	62	76	33	32	34	.001
Heard about any contests or events at school about cafeteria food choices?	20	40	56	8	9	7	.0001
Took part in any taste tests, food samplings, or contests in the school cafeteria?	21	41	61	4	4	11	.0001
Student perceptions, %: On a normal day, how many low-fat food choices are offered in							
Main lunch line?	5.6	5.8	6.0	5.7	5.7	5.4	.05
À la carte/snack bar line?	5.8	6.1	6.5	4.6	5.3	5.3	.004
Snack vending machine?	2.7	2.8	2.8	2.6	2.3	2.5	.41

^aP value for time × condition interaction. Means adjusted for grade, gender, and race/ethnicity.

weeks of each 40-week academic year demonstrated excessive variation attributable to start-up and termination processes. Therefore, data from these weeks were excluded from the analysis. Midyear levels (week 20) and slopes were fitted within each school and each year by time-series analysis²⁶ with the Prais–Winsten method²⁷ in Stata.²⁸

Meta-analyses of levels and slopes by year showed the variation between schools to be much greater than the variation within schools; unweighted analyses of variance for the intervention versus control conditions were conducted. Studentized residuals were examined but showed no overly influential points. Meta-analyses were conducted with SAS release 8.2.²⁹

Student survey data were analyzed with mixed-model analysis of variance that examined the effect on outcomes of the interaction between experimental condition and time. Schools were included as a random effect. The primary dependent variables of interest were the ratio of lower-fat to high-fat food choices, the added fats score, and the fruit and vegetable score, all of which were measured at the 3 survey time points. Perceived environment and behavioral intentions were secondary outcomes. Analyses were adjusted for gender, grade, and race/ethnicity (self-reported by students). The intervention effect was tested against the variability between schools, as is appropriate in a group-randomized trial.³⁰

Revenue data were not normally distributed and were not amenable to transformation to approximate normality. The Wilcoxon rank sum test was used to test for differences both in slopes and in level between intervention and control schools.

RESULTS

Process Evaluation

Percentage lower-fat à la carte product mix. At baseline, the mean percentage of lower-fat foods offered in the à la carte areas was similar in intervention and control schools (27.8% and 29.1%, respectively) (Table 3). However, by the end of the 2-year study, 42% of the à la carte foods were lower fat (an increase of 51%) in intervention schools, compared with 28% of the à la carte foods (a decrease of 5%) in control schools.

TABLE 3—À La Carte Food Availability Before and After Intervention

	Mean (Range)		
	All Schools (n = 20)	Intervention Schools (n = 10)	Control Schools (n = 10)
Percentage low-fat à la carte foods			
Baseline	28.9 (11 to 53)	27.8 (11 to 53)	29.1 (16 to 41)
Year 2 (end)	34.9 (16 to 58)	42.0 (28 to 58)	27.7 (16 to 39)
Absolute change (baseline - year 2)	6.4 (-7 to 27)	14.2 (4 to 27)	-1.4 (-7 to 5)
Relative change (baseline - year 2/baseline)	22.5 (-23 to 155)	51.1 (9 to 155)	-4.8 (-23 to 20)

Peer promotions. During the first intervention year, 49 promotions were conducted across the 10 intervention schools, 30 of which were primarily student based. During year 2, 127 promotions were conducted, 40 of which were primarily student based and 30 of which involved students, food service staff, and research staff. Most promotions lasted 1 day.

Student exposure. Compared with students in the control schools, students in the intervention schools were significantly more likely with time to report seeing posters or newspaper advertisements about foods in the cafeteria or participating in taste tests or contests in the school cafeteria, and they perceived a greater number of lower-fat foods to be available in the à la carte area and the main lunch line (Table 2).

Outcome Evaluation

À la carte sales. Figure 1 shows the fitted slopes for the percentage of lower-fat à la carte sales data during intervention year 1 in 2 intervention and 2 control schools. Schools were chosen for having slopes closest to the average slope within each condition. The intervention schools showed a significantly higher mean percentage of sales of lower-fat foods in year 1 (27.5% vs 19.6%, $P=.096$) and a significantly higher mean percentage of sales of lower-fat foods in year 2 (33.6% vs 22.1%, $P=.042$; data not shown in figure). Compared with control schools, intervention schools showed a steeper rate of increase in percentage of sales of lower-fat foods in year 1 (a 10% increase, compared with a 2.8% decrease in the control schools; $P=.002$). In year 2, the slopes of the percentage of sales of lower-fat foods did not significantly differ between intervention and control schools (2.0% vs 1.2%, $P=.76$). Ro-

bust regression analyses yielded models with essentially unchanged results.

Student-reported food choices. Table 1 shows the ratio of lower-fat to higher-fat food choices, added fats score, and fruit and vegetable score derived from student surveys by intervention group at 3 times. There were no significant intervention-related differences over time on any of these variables.

Perceived environment and behavioral intentions. Compared with students in control schools, students in intervention schools were more likely with time to perceive that the school cafeteria offered enough low-fat foods, that the adults at school encouraged them to buy lower-fat foods, that their friends usually bought lower-fat foods in the school cafeteria, that it was easy to tell which foods were lower fat, and that it was easy to buy lower-fat foods in the school cafeteria (Table 1). No significant treatment group differences were observed for intentions to buy lower-fat foods from the school cafeteria or other variables.

School food service revenues. No significant treatment group differences over time were observed for any of the food service revenue variables examined.

DISCUSSION

The results of this study clearly show that changes made in the school food environment to increase the availability and promotion of lower-fat food choices had a significant positive effect on sales of lower-fat foods to students. Furthermore, students perceived a greater availability of lower-fat food choices in the cafeteria à la carte areas and greater normative support for lower-fat food choices at school. These results were achieved with-

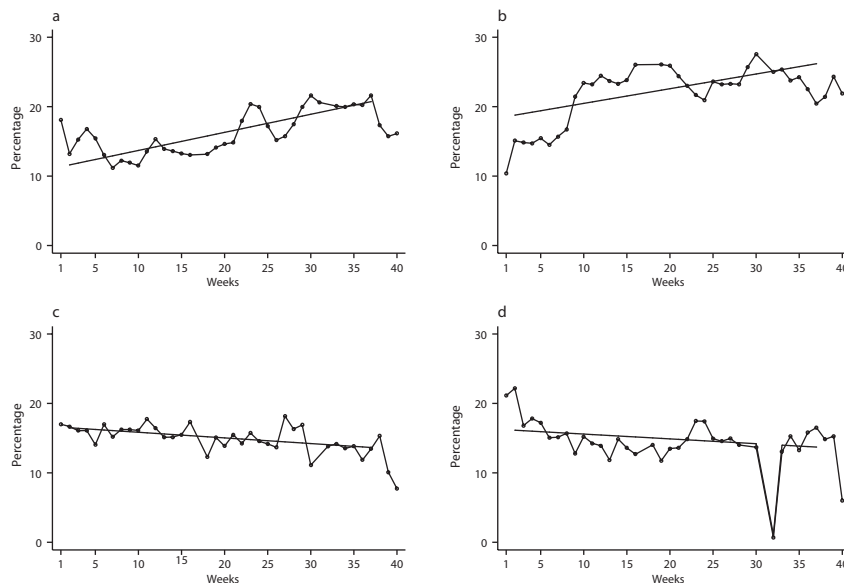


FIGURE 1—Percentage low-fat à la carte sales during intervention year 1 (2000) in 2 intervention schools and 2 control schools representative of TACOS. Shown are data and slope for (a) intervention school 1, (b) intervention school 4, (c) control school 15, and (d) control school 17.

out a classroom educational component or a home-based family component, which were included in most previous school-based nutrition intervention studies. These findings are unique and promising and indicate several potential strategies for improving adolescent food choices at school.

Schools are increasingly under pressure to meet curriculum and testing standards. Although giving greater time and attention to nutrition education is a priority for schools, health and nutrition, to date, have not received high priority in the classroom curriculum. Our findings indicate that school environmental changes can produce positive effects on food choices without a supportive curriculum specifically targeting food choices. Peer promotion groups can also achieve educational and motivational objectives in the promotion of healthy food choices with an engaging alternative to the didactic classroom curriculum. Involving students in promotional activities can foster positive peer norms in healthy eating as well as the development of positive relationships between students and food service staff.

The increasing recognition of the importance of school environmental influences on

student food choices has led to several state-level initiatives to improve the availability of healthful food choices in school cafeterias.^{31,32} These initiatives include efforts to limit availability of high-fat, high-sugar foods that may displace healthier food choices. Results from TACOS²² and from a statewide survey of secondary school principals³³ show that most schools have no school policy related to food and nutrition. Responsible school food policies can create a healthier food environment by ensuring the availability of healthful foods in à la carte areas and vending machines and by limiting the availability of higher-fat, higher-energy, lower-nutrient-density foods that compete with the healthier options.^{15,22,33,34} Our findings provide empirical support for these initiatives and demonstrate the potential positive effects of such environmental and policy changes on student food choices at school.

The revenues generated by the sales of high-fat à la carte foods and the potential effect on school food service revenues of changes in the types of foods available à la carte are important issues that must be addressed by policy changes regarding the school food environment.^{14,15,22,32,33,35} Our re-

sults indicate that increases in the availability of lower-fat à la carte foods had no adverse effect on school food service revenues.

This study had many strengths, including a novel intervention that addressed a timely topic for which few data are currently available. The sale of competitive foods in secondary schools is a controversial issue. Our data provide useful information about potential strategies for the current fiscal and regulatory environment and suggest innovations that could actually be implemented broadly in secondary schools at low cost. Our results are based on the 20 secondary schools that participated. Because choice of school was treated as a random effect in the analyses, generalization to schools similar to these schools is appropriate.

The null findings for the student food choice survey are difficult to interpret. One potential explanation is that the measure was not sensitive enough to capture the subtle changes in food choices that resulted from the intervention. Another possibility is that the random selection of students for the surveys may have failed to capture students who actually used the school cafeteria on a regular basis and who had maximum exposure to the intervention components. A third potential explanation is that a small proportion of students, perhaps those most interested in healthy eating, made changes in their food choices. Any of these explanations could have resulted in significant changes in low-fat food sales without significant changes in the food choices captured by the survey. Future research examining environmental interventions should measure both individual-level and aggregate-level behavior changes to better evaluate the effectiveness and the mechanisms of behavior change.

In conclusion, changes in the school food environment, such as increasing both the availability and the promotion of healthful foods, can have a positive effect on secondary school students' food purchases and on their perceptions about the food environment at school. Policies should be adopted that increase the availability of healthful food choices and decrease the availability of less healthful food choices at school. Students, food service staff, faculty, administrative staff, and parents need to be actively engaged in

school food policy development and implementation.^{15,22,33,34} ■

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Contributors

S. A. French conceptualized, designed, and implemented the study, wrote the article, and assisted with data analysis. M. Story contributed to study conceptualization, writing, and study implementation. J. A. Fulkerson contributed to study implementation and writing. P. Hannan contributed to the study design, statistical analysis, and writing.

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Human Participant Protection

This study was reviewed and approved by the University of Minnesota internal review board, human subjects protection committee.

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